HIGHLIGHTS ATTACHMENT 3

$PM_{2.5}$ MONITORING FORUM
MARCH 16-17, 1998

March 16

Introduction

Cynthia Marvin, Air Resources Board (ARB)/Executive Office (EO), (see Appendix CM):

- Charting a course for clean air
- Several public forums planned for this spring at locations throughout the state
- We are concerned about particulate matter due to health effects and impaired visibility
- Several areas in California violate $PM_{2.5}$ standard
- Technical expertise, current programs, and ozone/PM10 plans provide headstart
- There are ongoing/planned studies to better understand fine particulates
- Projects for 1998: implement monitoring plan, develop technical work plan

AQ History Presentations

Dr. Karlyn Black, ARB/Research Division (RD), (see Appendix KB):

- PM takes several forms from many sources, primary and secondary
- PM causes health effects based upon epidemiology study results
- There is a high degree of consistency and coherence among studies
- Health effects include: increased asthma attacks, reduced lung function, aggravated bronchitis, respiratory disease, all of which can cause premature death
- Most Californians breath unhealthy levels of PM with regularity
- Coarse PM deposits in upper airways; fine PM deposits deep in lungs
- PM size and composition, and size and major sources distribution

Michael Poore, ARB/Monitoring and Laboratory Division (MLD), (see Appendix MP):

- An overview of the PM_{10} dichot program includes: sample collection, analyses, stations, samplers
- California has a rich data base for $PM_{2.5}$ from dichot and the California Acid Deposition Monitoring Program monitoring networks
- $PM_{2.5}$ mass concentrations have seasonal and complex regional variation
- Constituents of $PM_{2.5}$: ammonium nitrate, carbon species, ammonium sulfate, crustal elements
- $PM_{2.5}$ trends by Air Basin are similar although maximum annual geometric means vary

Tony Van Curen, ARB/RD, (see Appendix TVC):

- Fine particle special studies in California support: effects studies, methods development, cost-effective control programs
- Source allocation needs measurements and control effectiveness requires modeling
- Visibility studies include: ARB Tri-Cities; U.S. EPA VISTTA; U.S. EPA IMPROVE; U.S. EPA, SCE and NPS SCENES, DoD RESOLVE, Navajo Power Plant, MOHAVE, Lake Tahoe Visibility Network
- Special Aerosol Studies include: ACHEX 1970's, SCAQS 1980's, Caltech early 90's, SCOS97-NARSTO late 90's
- Statewide Aerosol Studies include: Children's Health Study, CA Regional Particulate Air Quality Study (CRPAQS)
- State of the Art: aerosol behavior, sampling technology, continuous measurement

Karen Magliano, ARB/Technical Support Division (TSD), (see Appendix KM):

- 1995 Integrated Monitoring Study
- Objectives: 1) provide an improved understanding of elevated fall and winter PM concentrations,
  2) develop a database for preliminary model evaluation,
  3) provide information for more effective field program planning
- IMS winter domain: core sites in Bakersfield, Chowchilla, Fresno, Kern Wildlife Reserve
- Core sites represent 24-hour $PM_{2.5}$ concentrations
- Core sites $PM_{2.5}$ December 27, 1995, source contribution showed Bakersfield and Fresno to have large total carbon fractions and all sites to have comparable ammonium nitrate levels
- Fresno 3-hour chemistry data includes: nitrate ion and total carbon which make up large portion of total PM mass
- Kern Wildlife includes 3-hour chemistry data
- Bakersfield studies show spatial representativeness for PM
- December 26-27, 1995, data includes $PM_{2.5}$ organic carbon
- Implications for future monitoring include: enhanced temporal resolution, speciation, multiple sites needed to characterize population exposure within an urban area

Mel Zeldin, South Coast Air Quality Management District (SCAQMD), (see Appendix MZ):

- Intensive Study: PTEP in the South Coast
- Monitoring used to help show attainment for the standards which are expressed in terms of mass concentration
- Control programs need to know contributing sources
- Need to identify specific components of particles for planning
- Highest PM_{10} concentrations in South Coast are inland:
  - Riverside and south western San Bernardino County
  - ammonia source is from large area of dairy cows in San Bernardino
- Special NH_4^+ monitors used in study around ammonia sources
- Monitoring frequency followed in 1995 included:
  - first quarter 1-in-6 days
  - second quarter 1-in-3 days
  - last six months everyday
- PTEP study included a full complement of analyses for PM_{10} and $PM_{2.5}$
- Collocated samplers showed good precision
- 1997 comparison between PTEP and FRM was within about 1%
- PTEP data shows $PM_{2.5}$ higher than standard due to ammonium nitrate in San Bernardino area
- PTEP data can show seasonal variation, crustal components, oceanic components, etc.
- The study reported a lot of good data
- Expect to conduct another study in 1998/1999; PTEP 2000

Dr. Tom Cahill, University of California at Davis (UCD), (**no overheads**):

- The $PM_{2.5}$ Monitoring Network includes the IMPROVE samplers

- Clean Air Act of 1977 mandated:
  - measuring fine particles and other causes of visibility of national parks and monuments
  - identify cause of haze
  - if necessary conduct studies for mitigation
- Fine aerosols dominate light scattering
- IMPROVE program began in 1979/1980
- IMPROVE network provides speciation needed to identify causes of haze
- The network provides source information, trends, and technical support for mitigation
- Speciation allows separation of sources by size and composition
- IMPROVE network operates entirely with California technology
- IMPROVE samplers measure:
  - mass and trace elements on teflon filters
  - ions on nylon filters with a denuder
  - carbon on quartz filters
- Speciation needed for trends
- Technology has come a long way in providing highly credible measurements
- End result is mass and extinction of species to determine the amount of haze
- Ammonium nitrate is highest in the West
- Gradients show that fine particles are regional
- Speciation tells where to target efforts and is necessary for mitigation
- Ammonium sulfate trends in West are flat or actually improving and, in some cases dramatically, due to source controls
- Some of fine particles in East are coming from Africa
- Particle chemistry has shown that our intuition of fine particle sources may be way off

AQ History Questions & Answers (Q & A)

Q: Washington D.C. versus Shenandoah, was it organics and was it during the summer or winter?

A: Dr. Tom Cahill (UCD): Organics were identified in the winter, but not sure from where.

Mike Poore (ARB): A lot of fuel oil and coal are burned on the East Coast for heat and that can be where some of the organics are coming from. Also, it's very cold and that leads to condensation from the exhaust.

Q: There was mention of a statewide children's study and I know there is a PM health study going on in the South Coast. Are these studies one and the same or are they two separate studies? Also, are we looking at $PM_{2.5}$ or all PM in the children's study?

A: Dr. Karlyn Black (ARB): The ARB has been conducting a children's health study in the South Coast air basin and is looking at both PM_{10} and $PM_{2.5}$ with a variety of instrumentation to look at speciation as well as relative mass and comparability. The study is being conducted over a 10-year period following very closely a panel of school-aged children and looking, ultimately, at lung development and the incidence of health effects associated with that panel of children. We are anticipating to have some excellent data and

being able to draw some very solid conclusions about the effects on children certainly in this particular area.

Mel Zeldin (SCAQMD): There is another study South Coast has been involved in with U.S. EPA funding, and that is the Kaiser study. That study looked at the Kaiser health system which is fairly uniform across the basin on how they treat hospital admissions and how they handle medical records and merge that with the PTEP data from 1995. The PTEP study had a very comprehensive data set for PM_{10} and $PM_{2.5}$. The Kaiser study will be available in sufficient time to be reviewed. I know there were some interesting findings there. They did find some significant correlations in health effects, but the interesting thing was that those effects were found in the coarse portion and not the fine portion. In other words, the strongest correlations were found in the fraction of PM_{10} minus $PM_{2.5}$.

Dr. Karlyn Black (ARB): The PM fine or $PM_{2.5}$ issue on the table today from the monitoring perspective, is in response to a lot of regulatory issues. But from a health perspective, the health community is very interested in all particles that are respirable and includes coarse and fine particles. It's very likely that the coarse particles cause different kinds of health effects than the fine particles, or a combination of the two kinds of particles may cause another kind of health effects. I am hoping for a good discussion on this tomorrow. This whole issue of speciation and relative contribution to exposure is very relevant to health effects and is why we are here doing extensive monitoring and emissions inventory, etc., to get at the very real health question.

Q: Relative to what Dr. Tom Cahill (UCD) was saying, it appears that if you end up with the speciation data and the seasonal data and all the things that the speciation data show, that you may end up with different requirements for control if you look at things from the standpoint of health versus if you look at things from the standpoint of visibility. Is that true? In other words, certain components have a greater effect on visibility, but are those the components that have a greater effect on health? Or is health solely related to particle size and anything you do for visibility will be equivalently beneficial for health? Or do we have a situation where you may end up controlling for visibility and not having as great a benefit as you would like for health or vice-versa?

A: Dr. Tom Cahill (UCD): Those are very good questions. In terms of fine particles, people can see them. So, from the point of view of visibility, the correlation between what goes to the lungs and the particle size is pretty tight. As we look into more detail at visibility, we see that particles below about 1/3 micron are essentially transparent and you cannot see them but they do go deep into the lung. The correlation is not perfect. Also, we are interested in the gross components, particularly those that scatter light and especially those that are microscopic. Much of what we see scatter light at Shenandoah, is actually water. But it's water that would not have been, had it not been bound with some particle. We are very sensitive to hygroscopic particles in the size range of .5 to 1 micron diameter. It's not exactly the same things. U.S. EPA is very worried about ultra fine insoluable, <.1 micron in diameter. They are also worried about the documented health effects above 1 and 2 microns, especially because you can feel those particles in your throat. The point is that it is not a one-to-one correlation. That is why these networks tend to be different. We do a lot of speciation as a function of size and time, in eight or nine modes, which would really not be useful in terms of most health studies.

Q: I looked at the results of the evaluations of the monitors and the correlation is pretty good between the dichot samplers and the federal reference method (FRM) samplers that were evaluated, except for the particularly high concentration days. Do you have any idea what might be going on during peak days when the correlation is not as good?

A: Jeff Cook (ARB): I have some recollection of that study, but not a lot. I believe there were just a couple of days. I do not have a hypothesis at this point. We are talking about samplers that have the same characteristics in terms of flow rates and a number of other things. For me it's a little too early to tell.

Dr. Tom Cahill (UCD): We did a comparison between the IMPROVE and the FRM samplers that worked out pretty well. But at Bakersfield we had some problems on those days that were very humid. So there seems to be a possible water connection if those were the high days also.

Network Plan Panel Presentations

Bob Pallarino, United States Environmental Protection Agency (U.S. EPA), (**no overheads**):

- $PM_{2.5}$ regulations were published in the Federal Register on July 18, 1997
- Anticipate 37 chemical speciation sites in CA
- Chemical speciation samplers will be deployed in 1999
  - a multi-year phase-in

Kasia Turkiewicz, ARB/TSD, (see Appendix KT):

- There are 18 $PM_{2.5}$ Monitoring Planning Areas (MPAs) proposed for CA
- Network development process in cooperation and coordination with districts and U.S. EPA Region IX
- Proposed $PM_{2.5}$ network for 1998: 78 monitoring sites, 20 collocated
- Districts and ARB will propose sampling schedules that are appropriate for each MPA
- $PM_{2.5}$ chemical speciation: approximately 37 sites in CA

Mel Zeldin, (SCAQMD), (**no overheads**):

- South Coast AQMD $PM_{2.5}$ Plan includes:
  - 3 MPAs: Los Angeles, Riverside, Coastal (Orange Co.)
  - 4 collocated sites
  - Will apply for waiver for 1-in-3 day sampling rather than everyday
- Concerned about meeting lab requirements, training, and speciation
- PTEP 2000 will include:
  - speciation $PM_{2.5}$, PM_{10}
  - 1-in-3 day, 24-hour sampling to begin in August 1998 for one year
  - mass, ions, and carbon
- Public Forum in Los Angeles on April 22 and 23

Mike Basso, Bay Area Air Quality Management District (BAAQMD), (**no overheads**):

- Bay Area AQMD $PM_{2.5}$ Plan includes:
  - 9 stations for 1998: all except for San Jose are neighborhood scale
  - trying to site San Jose as neighborhood scale (alternate: Morepark)

- requesting waiver from everyday sampling until 4/99
- proposing 1-in-3 day, but 1-in-6 day during low season
- transport sites in Vallejo, Livermore
- 2 collocated sites: San Francisco, San Jose
- speciation sites: Concord, Livermore, S.F., San Jose in 1999

- Data available for TEOM at San Jose for 4 years, and dichot for 11 years
- Data available for TEOM at Livermore for 2 years, and dichot for 2 years

Dave Jones, San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), (see Appendix DJ):

- San Joaquin Valley Unified APCD $PM_{2.5}$ Plan includes:
  - 1998: 9 sites; 1999: 2 additional sites
  - 5 sites will be operated by CARB
  - 6 sites will operate everyday; others on 1-in-3 day schedule
  - CARB will perform lab work

Network Plan Panel Q & A

Q: I heard that the speciation sampler is going to look a lot like the IMPROVE sampler; and if so, will it basically be the IMPROVE sampler?

A: Bob Pallarino (U.S. EPA): It will be very similar to the IMPROVE sampler.

Jeff Cook (ARB): The IMPROVE sampler has been talked about a lot in terms of speciation, but there have been some questions as to whether it is acceptable in high concentration areas. R&P has submitted a suite of Partisol type samplers for consideration as speciation samplers. A national contract will be awarded at the end of this month (March) and at that time we will find out exactly what U.S. EPA officially feels the speciation samplers should look like, at least for this go around. U.S. EPA wants a network of 50 sites nationwide that are uniform and consistent to note trends across the U.S. We are trying to encourage U.S. EPA to allow states and locals flexibility to use potentially different types of samplers at the remaining 250 sites. There are other things down the road U.S. EPA is planning for speciation, so it is pretty much wide open at this time.

Q: How are you going to deal with funding for non-grantee agencies and how do non-grantee agencies apply for funding?

A: Bob Pallarino (U.S. EPA): U.S. EPA is funding the $PM_{2.5}$ program under the 103 Grant process. We normally grant funds to state and local agencies under the 105 Grant process which requires matching funds from the grantee agencies. This is normally a 60/40 split. Under the 103 Grant program, which will only be around for the first two years of the $PM_{2.5}$ program, we are funding 100 percent. Region IX made grants to grantee agencies in California and would rely on California to pass money to non- grantee agencies. We have also been working with CAPCOA to pass money to non-grantee agencies to cover operation costs for those districts that will be operating $PM_{2.5}$ samplers in 1998. We will use this same method next year if it is successful this year. Keep in mind that U.S. EPA is purchasing all the samplers for the state and local grantee agencies and will be providing them with operation money.

Q: If U.S. EPA is providing the monitors, and there are several vendors making these FRM monitors, are the districts going to have the option to choose which monitors they want? I know their operations will be much simpler if they were all from one manufacturer.

A: Bob Pallarino (U.S. EPA): That is a very good question. The AMTAC group discussed very early on as to whether or not there was going to be any consistency through-out the State on any particular sampler type. I am not sure how the national contract will work. U.S. EPA said they will try to honor requests if a state made its preference known before March 31, when the first order will be made. CAPCOA has discussed this, and it appears that everyone in the State wants to go with the same samplers.

Q: In regard to speciation monitors, in particular the first 50, will there be any field testing before they are released?

A: Jeff Cook (ARB): My guess is that this first group will be a homogeneous group. U.S. EPA wants a NAMS group of speciated samplers. We have not stated a preference because we do not know what is out there. I think the first 50 will be decided by U.S. EPA. As far as field testing, other than what has been done with the IMPROVE sampler, it is tough to speculate on what field testing might be done since we are not sure what will be used. But the IMPROVE sampler is a leading candidate for the first iteration.

Mel Zeldin (SCAQMD): From our perspective, we would certainly like to keep the PTE samplers for speciation. They are basically the modified stack samplers and have been used for the better part of a decade. We have had a lot of experience with them and our side-by-side comparison with the FRMs showed amazing agreement. We are comfortable with them and I hope we will be allowed to use them for speciation.

Q: PM_{10} monitoring has always been on a 1-in-6 day schedule, often misses the peak days and is not always representative. The $PM_{2.5}$ monitoring will be 1-in-3 day or everyday depending on the type of monitor. Will that play back into PM_{10} monitoring and is there anything in the works to change the PM_{10} sampling frequency?

A: Bob Pallarino (U.S. EPA): For PM_{10} sampling, the final 40 CFR 58 regulation that came out in July required PM_{10} sampling frequencies at a minimum of 1-in-3 days. Initial reaction from our state and local agencies was one of disbelief. U.S. EPA was sending mixed messages to state and local agencies on PM_{10}. On one hand, we were encouraging state and local agencies, where possible, to begin downsizing their PM_{10} network. That really did not make much of an impact in California since you have your own PM_{10} standard and you need to monitor to show compliance with that. But then on the other hand we are saying increase your sampling frequency to 1-in-3 days. The purpose of downsizing the networks was to get additional resources to support the $PM_{2.5}$ networks. U.S. EPA got a lot of feedback from the states on that requirement. So we went back and looked at the wealth of PM_{10} data in the data base and did a statistical analysis. From this we came up with a list of areas that were eligible to retain a 1-in-6 day sampling schedule. These are areas that are having a problem meeting the annual standard and are not concerned with violating the 24-hour standard. There were only a few sites in California that were not eligible, but there is some resistance at those sites to go back to 1-in-6 day sampling. Some districts said

they would just put a continuous PM_{10} sampler at those sites that are not eligible for 1-in-6 day sampling. At this point we have not reached a final agreement as to which sites will go on a 1-in-3 day schedule.

Mel Zeldin (SCAQMD): It was a big surprise to see 1-in-3 day sampling in the final promulgation since there was no advanced warning. The concern that we have is that you can use a continuous monitor to satisfy that requirement, but the continuous monitors do not give sufficient repeatability to the reference method. Even though they are acceptable equivalent methods, especially TEOMs, there will be loses where there are a lot of nitrates. Our concern is if we use a continuous monitor, we are meeting your requirement but we are degrading the quality of the data collected. So there have to be trade-offs here due to resource limitations because there is only so much that can be done at the local level.

Q: What is the rationale for everyday sampling with $PM_{2.5}$?

A: Bob Pallarino (U.S. EPA): California is different than a lot of other states in that they have a lot of $PM_{2.5}$ data already. There are a lot of states that have never collected any $PM_{2.5}$ data. U.S. EPA's concern was to quickly build a large data base to support future health studies which we are required to do in the year 2002. Relying on 1-in-6 day data would not allow for a proper conclusion. But in the case of California, it is quite clear that California has a very good understanding of $PM_{2.5}$ compared to other states. From that point of view, I think we could be a little more agreeable to relaxing the $PM_{2.5}$ sampling frequency requirements. Especially in the case of the San Joaquin Valley, there is an acknowledgment that during certain times of the year they do not need to do everyday sampling. But there are other times of the year when there is not much there, so it does not make sense to collect that much data during those times. Why do we need all this data? That is what should determine your sampling frequency along with who is going to use the data. We do not want to collect data just for the sake of collecting it and have it sit in the data base and shove it on the shelf and never use it again. It is very expensive to collect this data. So you need to maximize your resources and use them most efficiently.

Q: Will more $PM_{2.5}$ samplers be required as California's population grows?

A: Bob Pallarino (U.S. EPA): I have not heard agency (U.S. EPA) discuss this. I think this will depend upon how representative the network is at that time. If you are dealing with a lot of different pollution sources, you will have to take a look at the network. I do not see U.S. EPA changing the requirements and saying, for example, that 10 years from now we are going to require four core monitors for every populated area greater than 500,000. What we have now is just a starting point. We are required to review the networks every year and make any changes to address any inadequacies. So as the population grows you may want to add more monitors, but I do not think U.S. EPA will be requiring that. But in California, it is evident they want a network that is giving them the best information and to let it degrade would not be in their best interest.

Mel Zeldin (SCAQMD): One thing that I would hope happens over the next decade is to get better technologies. To get automated instrumentation not only for mass but for speciation also. When that automation occurs, the cost of maintaining the network, laboratory, etc., should hopefully go down. Given that, in the future it may be more economical to maintain a larger network than it will for the next couple of years because currently manually-labor intensive to get this program started.

Q: What if in some areas with side-by-side speciation monitoring along side the FRMs it's shown that the FRM sampler, at least in that area, does not give an accurate assessment of the airborne non-water particulate matter below 2.5 microns?

A: Bob Pallarino (U.S. EPA): Loses due to high temperatures are not as big of a problem as first thought.

Mel Zeldin (SCAQMD): South Coast did a study last year which showed that nitrate loses over 96 hours were very low. There was some loss, when the temperatures were high, up to about 15 percent. But the nitrate levels on those days were generally very low as is the case normally in the summer. Using PTEP data from 1995, nitrate loses from quartz filters were about six to eight percent and with the teflon filters that may even be less.

Jeff Cook (ARB): We are required by a State law, signed last year, to pursue development of accurate speciated samplers. Therefore, we need to continue to press for accurate species. It is incumbent on us to develop an accurate method to track in the ambient air the effect of controls, even if only for one of those species (i.e., NOx). So if not for an accurate mass number, then certainly for that purpose (the requirement of the State law) it is our obligation to do that.

Q: How does the IMPROVE sampler differ from the FRMs?

A: Bob Pallarino (U.S. EPA): My understanding of the IMPROVE sampler is that it differs from the FRM mostly in the fact that it uses three different types of sampling media (quartz, teflon and nylon) to collect concurrent samples. It enables you to do different analyses so you can capture the whole array of various elements that are contributing to the $PM_{2.5}$ concentration.

Q: Has U.S. EPA come up with any guidelines for reducing the number of PM_{10} sites?

A: Bob Pallarino (U.S. EPA): If you have a PM_{10} site, based on the last three years of data, recording values 60 percent or less of both the 24-hour and annual standards, this site would be a candidate for shutdown.

Jeff Cook (ARB): However, do not forget the State standard. Because of the interest in PM_{10} at the time, the network that exists now is mostly State and local funded. So there is not an economy of scale, at least on the federal end, to reduce the PM_{10} network because these are State and local dollars invested in those samplers.

Dr. Karlyn Black (ARB): As a health professional, I would like to add that we still need coarse particle measurements and continuance of a solid PM_{10} data base. There is a great deal of emphasis in why we are here today in looking at the fine particles, but I want to emphasize that the fine particles are not the whole story. All particles 10 microns and smaller are respirable and we need to get a handle on looking at the health effects associated with the various species and also the size cuts that those species are found in. It's not enough to say, now we are looking at fine particles, let us abandon the 10 micron size cut, because I think that would be short-sighted.

Agency Panel Presentations

Dr. Richard Scheffe, U.S. EPA/Office of Air Quality Planning and Standards, (**no overheads**):

- Need process measurements to identify specific controls that will work
- Mass needs to transition to speciation to focus on health impacts and effective control
- Define more fine particle/health/ozone connections
- Need to consider the atmosphere as an entity
- More continuous data are needed
- There will be a summer conference (health/plan) on National level

Dr. Bart Ostro, Office of Environmental Health Hazard Assessment (OEHHA), (see Appendix BO):

- Need adequate spatial and temporal coverage
- Want monitoring for epidemiology and not just compliance - health standards were based off the epidemiological study results from samplers (i.e., daily data)
- Range of cut size particles would be useful - want collocated fine and coarse fractions
- Like daily information especially for morbidity, asthma attack
- Want information from ARB on reliability and validity of real-time $PM_{2.5}$ monitoring

Dane Westerdahl, ARB/RD, (see Appendix DW):

- Hourly TEOM PM_{10} versus 24-hour PM_{10} concentrations during episode on 11/1/94
- High PM_{10}/low ozone (1/2 hour time frame) - size and composition change over even short periods of time
- Want to determine what people are exposed to (not population but people)
- Are smaller particle sizes important? (i.e., 0-2)
- Chemical speciation H^+
- Method equivalence - proven analysis methods - how well do they work? Which is right? Under what conditions?
- Continuous surrogate monitoring calibrated to mass monitoring needed (i.e., make the bridge or connection)
- Prolonged long-term monitoring needed
- Need to establish link between population vs. people monitoring
- FRM will not be useful for health studies - will give linkage to mass and population based monitoring - does not give enough details for health impacts
- Indoor/personal exposure monitoring and personal sources - currently only pump impactor for monitoring - need more robust and time sensitive monitoring
- Gas to particle conversions - refine optical monitoring
- Nitrates/other volatiles monitoring methods are needed
- STETsingle particle analyzer STET chemical and time resolution
- Increased meteorological monitoring for modeling is critical

Mel Zeldin, SCAQMD, (**no overheads**):

- Need to develop automated FRMs/FEMs
- Continuous speciated monitors needed
- Special purpose monitors needed
- There are budget and manpower concerns with manual FRMs

Dave Jones, SJVUAPCD, (**no overheads**):

- Adequate network data (FRM/FEM) to determine attainment status for the $PM_{2.5}$ NAAQS
- Network that will act as a backbone during comprehensive field studies
- A comprehensive network of real-time $PM_{2.5}$ instruments to assist in air quality and agricultural burn forecasting
- Representative exposure sites to provide data for determining population exposure
- Monitoring network that provides baseline data for planning comprehensive PM studies
- Speciation data suitable for use for analyzing source contributions
- Monitoring data needs to be suitable for tracking control strategies via trend analyses
- Network data needed to assess transport of $PM_{2.5}$ between regions
- The network needs to be useful in any future Regional Haze Program

Avi Okin, BAAQMD, (**no overheads**):

- 1990/91 winter exceedances - arctic mass settled over Northern CA - conducted study to show PM10 attainment - highest number was 120, well below national standard - wood smoke primary source
- Needs: source emission rates, chemical reaction rates - continuous sampling will help - speciation for control technology effectiveness
- Transport winter study with SJVUAPCD in 1999/2000

Andrew Ranzieri, ARB/TSD, (see Appendix AR):

- Available PM air quality models: Speciated linear rollback, receptor models, observation based methods equilibration models, 3D grid-based models, model performance and application for SIP
- Data needs: Continuous PM data-size resolved and chemically speciated, continuous measurements of precursors and secondary gaseous pollutants, meteorological measurements at the surface and aloft
- Data analysis & emissions inventory: Locations of high concentrations, temporal and spatial variations, source attribution, transport assessment, trend analysis, concentrations aloft, background concentrations

Dean Saito, ARB/EO, (**no overheads**):

- Need to assess ozone design strategy and how it interacts with PM because existing ozone controls have reduced PM
- Control strategies: will they be effective for both 24-hour and annual standards?

Agency Panel Q & A

Q: In clinical studies, is it important to investigate different concentrations over time?

A: Dane Westerdahl (ARB): I do not think we are ready to ask this question in clinical studies. We are still at the point of how to expose people to real atmospheres once the chemists can tell us what those are. We are quite a ways down the learning curve in terms of what time resolution of exposure and response should be.

Q: In terms of speciation, any idea what set of compounds people should look at?

A: Dane Westerdahl (ARB): Organic compounds have been a concern in the health community for their carcinogenic potential. There is very little information that compels us to do specific organic exposures. There is no information to decide this. That is why we usually start out with epidemiologic studies that identify issues. So you need the complex monitoring to figure out how to identify the issues and then you can figure out in a controlled atmosphere which components may be most important.

Dr. Bart Ostro (OEHHA): I would add sulfates and nitrates to the mix. They should be looked at over long periods of time as well.

Dr. Tom Cahill (UCD): It is very clear that what people are concerned about this year will be something totally different three years from now. Therefore, our ability to anticipate the needs of the health community is limited. As we start to talk about sample collection and analysis, we should talk seriously about long-term archiving of samples. This is so that four, five, or six years from now we can pull the samples from a freezer and then maybe find a species identified from some other study as being critical. This is an area that is traditionally ignored. So as we start a plan, I think there should be ARB-guided/U.S. EPA-certified archiving technology to make sure part of the samples are available in future years for more detailed analyses.

Dr. Karlyn Black (ARB): From a health perspective, in terms of designing your clinical studies, there is a need to get a handle on atmospheric chemistry and the major components that we find in the atmosphere. Once we feel that we can identify health effects due to those major components, we can look at the interactions between those components. Also, we can look at some of the more minor components from an overall mass or overall constituency, but maybe more major in terms of health considerations. So we have a lot of work to do on the clinical front. We have to be very systematic about it in terms of exposures to be able to make sure when we move into these different atmospheres, for clinical exposures, that we make sure we have adequate mixes and representative mixes.

Q: In consideration of application of continuous monitors, to what extent are you considering visibility measurements?

A: Mel Zeldin (SCAQMD): At this point in time, we have not put a lot of emphasis on visibility measurements per se. We have two sites that are currently collecting data from nephelometers. I think serious consideration needs to be given to the visibility component and certainly the one that the public reacts to most readily, as far as manifestation of air pollution in general. We have to do a better job of getting that data base collected as well. When we put together our plan, this will be considered. But, I do not have a firm answer at this time. We ought to take advantage of the technology that is available to give us continuous measurements. I cannot emphasize enough how important it is for us to push the technologies to get the type of data we need and the time frames that we need. We cannot take a sit back approach and just let it happen, because it will take too long. We need to make a concerted effort to

make it happen. There are people out there that have the capabilities to develop the right technologies, test them, prove them, and ultimately commercialize them. We need to put this forward at a fast rate.

Q: The suggestion was made that perhaps, in the interim, resources could be better spent with an every third-day sampling program. However, time-series mortality studies really need daily data. What do you think of the alternative of having fewer sites, some of which at least are devoted to daily sampling during this start-up period, rather than running all samplers on an every three-day basis? This would allow people to do the kind of time lag analysis, etc., with the PM data that is critical. The PM time-series mortality studies were among the most important in establishing the standards, so having that kind of data as soon as possible is very important.

A: Mel Zeldin (SCAQMD): I recognize that and it is an important consideration. I would like, however, to push the effort to get good continuous monitors so that you have that sort of data. U.S. EPA recognizes that if you run a correlating continuous monitor, I think for a two-year period, you can go to 1-in-3 day sampling and use that device to estimate the daily $PM_{2.5}$. So clearly there is a recognition that over time the continuous monitors would serve that purpose. All I am saying is that we need to push and advance technologies so we can bring better equipment on-line and have more confidence in the data. This will provide the health needs, and at the same time, reduce the labor intensiveness of the whole network operation. We may need to go manually for a short period because there is no other choice. But I would rather see, at the expense of one or two years of having this type of labor intensive operation, us move with the same monies and develop the technologies that are going to provide the benefits in the years to come.

Q: I would like to offer the following to the districts in terms of the dilemma between collecting a lot of data and addressing the health needs at the same time. How about having a more intense sampling frequency only during those periods where there is a suspected problem? Problem areas can be identified through historical data over the last decade, whether it be from TEOM, BAM or our PM_{10} sampling networks. For example, in the San Joaquin Valley we suspect the more intense sampling may be in the winter season and the same type of thing in the Los Angeles basin. Also, some type of objective on when and how to sample could be established based on historical records. The rest of the time could be relaxed so that the resources could be used to develop continuous monitoring. So some kind of compromise could be worked out. I think we all realize that during large parts of the year there is probably not the necessity in California to have intense sampling everyday.

A: Dave Jones (SJVUAPCD): In San Joaquin Valley, we are proposing to concentrate sampling during the first and fourth quarters of the year. It needs to be done by quarters, because annual averages are done by quarters. We are proposing to do every sixth-day sampling in the second and third quarters. In our major cities, Fresno and Bakersfield, we would have one of the three stations operating daily during peak seasons and the other two stations operating on an every three-day basis.

Dr. Bart Ostro (OEHHA): I think there is some merit to that. But the problem with that is that the debate on standards setting is at the low end. I think we would be remiss if we did not monitor at all during some of the so-called cleaner periods of time. The standards-setting debate is really what is happening at 20 and 30 micrograms, not at what is happening at 100 and 150 micrograms. So I would not like to see exclusion at the low ends.

Q: Regarding episodes, districts have an ozone episode rule and we have not had much for particles. I think we have not had much for particles because we only have once every sixth-day monitoring and we might miss a lot of the episodes. Given that we are finding potentially more severe health effects from particles relative to ozone, it might suggest we be more attentive to episodes for particles. Do you think this might be another reason for more regular monitoring for particles?

A: Mel Zeldin (SCAQMD): On the episode, there is one difference between that and ozone. I think that from an ozone standpoint because it is an hourly standard, you can take a look at what is happening real-time and make announcements or advise the public as it is happening. With PM_{10} and $PM_{2.5}$ it is a 24-hour average that ends at midnight, and especially if it is filter based, you do not know until well after the fact. So if you are going to have an effective episode or public notification program, the only way you can effectively do that is on a forecast basis. If you are going to develop forecast models, once you have a sufficient data base you can construct those predictive models irrespective of whether you are continuously monitoring once there is a historical data base to work with. We have the 1995 PTEP data and our meteorologists are now working on a forecast method which is showing pretty good promise. We will be able to make those notifications to the public whether we have the real-time data or not. The collected real-time data allows us to build, in the future, a data base so that we can refine and improve the predictive models over time. But there is a clear difference in how that is handled from a public notification standpoint between PM and ozone.

Dr. Tom Cahill (UCD): One alternative approach is to sample richly and analyze selectively. This is especially important for speciated organics.

Dr. Walter John (PSci): One way to do this is to sample at a low flow rate over a long period, like a week. That reduces the number of samples and you cover all the time. With regard to cutting down on the load, I think you need to sample all the time because epidemiology is based on associations. So you need low as well as high data. A better way to free up resources is to sample in fewer locations. Sample where the people are, to identify health effects.

Q: From a modeling point of view, it is critical to have vertical profile measurements of aerosols. Is there any plan to have vertical profile measurements or are these all surface based measurements?

A: Mel Zeldin (SCAQMD): I am not aware of anything that requires any 3D measurements other than to have placement of certain monitors at elevated locations. Vertical profiling is an important point, however, because of the needs required of future monitoring. Future monitoring is needed to accomplish the needs of the health experts, for good health studies, and to meet the needs of the modelers. So we need to find out what is needed from the modelers. After all, modeling helps drive the result and control strategies. I will guarantee you that for $PM_{2.5}$, the costs for meeting these standards will certainly dwarf, by probably orders of magnitudes, the funds that are being committed to this monitoring program in the first place. Therefore, we need to pay attention to those needs and address them the best way we can, for example, through special studies.

Q: All of you want continuous monitors. Do you have any mechanisms for funding that kind of development?

A: Mel Zeldin (SCAQMD): At this point we do not. That is why I would rather sacrifice a little on the network and free-up some of the 90 million dollars available to go into the work to develop the technologies and move them along at a faster rate. I think it will pay dividends in the future.

Dr. Richard Scheffe (U.S. EPA): There is a requirement to do continuous monitoring in the 52 largest cities in the country. As part of the overall program, we assume about 100 cities will conduct continuous monitoring, but some of the funding may be delayed until the year 2000. There is also another element. Not every site is the same. Not every site has a FRM. Local districts and states have the option of purchasing continuous monitors and locating them at a number of sites. They are simply sites (special purpose monitoring sites) which would not be eligible to be compared to the standard.

Jeff Cook (ARB): One initiative U.S. EPA does have is a joint project with Battelle where they are trying to advance the state of technology. The thinking is that there will be a market for certain types of instruments for such things as continuous precursor measurements. This is separate from the FRM program. We met with Battelle and we identified the need to develop continuous correlated instruments to the FRM and the need for continuous speciated measurements. The expected benefit of this is that Battelle will set up test protocol for instruments and solicit vendors to bring their instruments in for evaluation and hopefully verification. With that, potentially the market will grow.

Avi Okin (BAAQMD): Let me add to that. We currently have around one of our refineries what we call a fence line monitor. It is basically a lidar type instrument. This type of technology may be useful in a remote location, given the power requirements, and may be able to measure aloft continuous particulates among the many compounds this lidar-type instrument can measure. This may be one area where technology needs to be pushed towards.

Q: What is being planned to establish emissions data for particles which are needed for modeling?

A: Andrew Ranzieri (ARB): In regards to PM, the ARB has done a lot of work with the agricultural industry to develop a temporally-resolved agricultural-related PM inventory for the San Joaquin Valley. In addition, there is work being done by the San Joaquin Valley Unified APCD to improve some of the inventory components (such as the agricultural internal combustion engines which were not a component back when the 1994 State Implementation Plan was prepared). There are other ongoing programs that ARB has been supporting to improve the inventory (the precursor parts of the PM problem).

Linda Murchison (ARB): A lot of our focus until now has been on the PM_{10} inventories and we have done some extensive work at looking at PM_{10} in the San Joaquin Valley, particularly as it relates to agricultural categories. Staff have worked closely with the agricultural community to get very specific monthly and very short-time frames kinds of temporal data, and also spatial data for characterization of PM_{10} for the San Joaquin Valley. For $PM_{2.5}$, we are looking to do some additional research to get $PM_{2.5}$ emission factors. We are working on the ammonia inventory as well. We are also working on some national committees to learn what is being done by other states that are looking into the $PM_{2.5}$ area. It is new to us and I think some of the things mentioned about starting early and developing the tools early is something that we recognize and are doing. We are participating in this effort because we want information from the monitoring data to help us target in very specific sources so that we can concentrate our efforts and resources on those sources that contribute great to the $PM_{2.5}$ problem as opposed to just the PM_{10} problem.

Q: What are you planning to do about the background off the coast of California and the background coming up from Mexico?

A: Andrew Ranzieri (ARB): Good question. Concerning the coast of California, we are planning a large scale field monitoring program for the Central California Regional $PM_{2.5}$ Air Quality Program. This will take place in late 1999 into the year 2000. As part of that design program we were going to try and determine the appropriate location, type of measurement and frequency to gather that information. The design is being worked on right now by Dr. John Watson of DRI. As far as what is coming up from Mexico, I cannot comment on that because I have not worked in that area.

Dr. John Holmes (ARB): We are currently working closely with the Mexican government on air monitoring and emission inventory. The question of whether transport, which is significant in Tijuana and Mexicali, is going to be reduced is a whole different area. It is difficult to tell exactly what the Mexican Government is going to require of their border states. We hope that they will be able to do something to help us out.

Dr. Tom Cahill (UCD): There needs to be more work done on the size distribution of the natural oceanic materials including organics and sulfates coming across the ocean.

Q: How do you propose to have all air quality data from all sites more readily available for people to see and use?

A: Andrew Ranzieri (ARB): One of the problems we found is that some of the data is not quality checked. Some of the data is instantaneous, some of it is hourly, some sites have different siting requirements. If the data is not quality checked, it could be difficult to use. It is a problem and is something that needs to be worked on for one central location to retrieve data from.

Bart Croes (ARB): We have an aerometric data base that has been worked on at ARB for the last six years. Right now it has 150 million measurements primarily from ARB and the districts. But our plan is to include a lot of special monitoring programs and intensive field studies, and try to do a common quality check on the data. Last month we unveiled Web page access to that and we have been distributing CDs with the last 17 years of data here in California.

Stakeholders Comments

Cindy Tuck, California Council for Environmental and Economic Balance (CCEEB), (**no overheads**):

- Assurance that adequate speciation monitoring data is obtained - not just mass
- Assurance that meteorological data is obtained
- Placement of monitors to represent human exposure
- Maintaining a sufficient sampling frequency to ensure a robust data set

Cathy Reheis, Western States Petroleum Association (WSPA), (see Appendix CR):

- Critical needs for PM monitoring data include:
  - Exposure and epidemiological health studies
  - For planning purposes & conceptual understanding of PM formation
  - To relate to visibility degradation

- Health needs include:
  - Identifying the relationship between community monitors, indoor monitors, & personal monitors for:
    - PM coarse species
    - PM fine species- full speciation
    - Short time frame of 3 or 4 Hours
- We need specialized monitoring for epidemiological studies for size fractionation and speciation by size along with the following:
  - Concurrent meteorological information, and
  - Concurrent gaseous measurements
- The planning and conceptual model needs include:
  - Representatives of monitors for fine and coarse fractions, including species
  - Movement to non-filter type of monitoring with:
    - short time frame, down to one hour if possible
    - "real time" versus wait for filter analysis
  - Concurrent meteorological and gaseous measurements at the surface and aloft
  - Source profiles which reflect what is being monitored in ambient
- Visibility needs include:
  - Identification of the correlation between visibility and PM fine using a surrogate measurement technique
  - Short-term, size-segregated, speciated measurements to improve extinction efficiency correlation
- In summary, we need:
  - Non-filter alternatives
  - Short term to "real time" measurements
  - Full speciation by size
  - Concurrent gaseous and meteorological measurements
  - Correlation between indoor, outdoor and personal monitors

Earl Withycombe, American Lung Association (ALA), (**no overheads**):

- Public notification - alert sensitive individuals (need real-time monitoring to give the alert - mass oriented) forecast capable - provide to people not just via WEB but by news media also
- Mesoscale saturation studies are needed around urban areas to identify seasonal impacts
- Environmental justice and growth areas need to be included
- Health based message is most critical - need connection of cause/effect (i.e., mass vs. constituent, moisture effects, interaction with other pollutants)

Stakeholders Panel Q & A

Q: Dr. Susanne Hering (ADI): You mentioned the need for continuous measurements to be able to provide notification. You also specified that you wanted this to be a mass-based measurement. I think from a technical point of view it may be easier to come up with chemical speciation continuous measurement methods that would cover the major components of $PM_{2.5}$, namely, carbon, sulfate and nitrate. The technology for doing that is actually closer at hand than for doing the accurate mass. Would the Lung Association be willing to accept something that covered all the major components?

A: Earl Withycombe (ALA): The reason I raise that question is because the ongoing debate in the research community is to whether it's the number and mass in particles versus the chemical composition. There is not a clear answer to that question at this point. There are epidemiological studies which are mass-based and which show better correlations with mass than with at least a couple of constituents, sulfate for example. There are animal studies, the dog studies, which perhaps open the door on an explanation of premature mortality. These studies suggest that, at this time, we seek a system which measures mass on a real-time basis. If, in response to your question, we have tools more readily available to measure the major components of mass but exclude some components that are difficult to measure and will require additional development in the technical field, we would support that. And I would also say that if there comes a time when the health effects research, the clinical studies, suggests that certain chemical constituents are primarily responsible for the health effects of premature mortality, onset of asthma, and chronic bronchitis attacks, then we would strongly recommend that those constituents be given priority for continuous monitoring and reporting, just like molds and spores are for those folks that suffer allergies in the spring. We see an analogy, but at this time we do not feel the research data is robust enough to go only to the constituent monitoring basis.

Dr. Susanne Hering (ADI): I was not proposing eliminating mass monitoring, but when you mentioned the continuous monitoring needs, you specifically mentioned mass and I just wanted to bring up the fact that it is probably easier, technically, to do the major constituents than to do the mass. Therefore, I think there is some value in it. I also would like to point out that particle number concentrations and fine particle mass are not very well correlated. So measuring fine particle mass is not going to tell you anything about the particle number concentrations.

Earl Withycombe (ALA): Again, our feeling is that the jury is still out on whether it's the number of particles that overwhelms macrophages or whether it's the mass of particles. Until the scientific community and the health research community gives us a clear answer, and there may be one that I am not aware of yet, but until that answer is solved, to us, it's a valid question for consideration.

Dr. Susanne Hering (ADI): I think it's been solved. I think there is a bit of a catch-22. You see the correlations with what has been measured. So to answer these questions, you need a broader spectrum of measurements.

Q: Jeff Cook (ARB): I have a question for Earl and that has to do with public notification-type of forecasting. Given that we have, at present, filter-based measurements whose information you do not get for days, I think Lowell alluded to this earlier, and we do have a 24-hour standard that, regulatorily, starts at midnight and goes to midnight, have you given any thought to how you might use sub-24-hour measurements effectively integrating it into a forecast that could be used in time for people to take preventative actions, or be notified of the following day?

A: Earl Withycombe (ALA): We know from some of the research data that was reported in the criteria document, for instance, that clinical studies with exposures as short as six minutes have produced adverse health effects at very high concentrations. We also have anecdotal information regarding the episode that occurred on November 1, 1994, which was graphically displayed by Dane (Westerdahl). Our offices were flooded with complaints about adverse health effects and the need for notification of these kinds of episodes. We have worked, lobbied actually, with the Air Resources Board for the last three years, on and off, to put resources into the development of a forecasting tool for PM_{10}. But we knew that PM_{10} is

such a localized pollutant like CO, that forecasting is very difficult. Although they made an excellent try evaluating available data, it was a task that I do not think is solvable with the data base that we have in hand. We do not have the kind of extensive data necessary to do the sort of microscale analysis all over a community. We are more encouraged by an opportunity to do this, however, for $PM_{2.5}$. We look at $PM_{2.5}$ as more of a regional pollutant like ozone. And we sense that with the success that we have experienced and through work by Fred Lurmann and others, that we can develop a forecasting tool not so much from the data available but from the data that we would acquire in the first two or three years of operation of this new monitoring system. And I should tell you that, in fact, we are encouraged enough that we have asked that language requiring ARB to develop that modeling tool for the Sacramento Valley be included in legislation that is now pending, AB1699 by Ortiz. That particular bill also asks that any unique health effects resulting from rice smoke, which is one of the few pollutants or components of particulate in this region that we think may uniquely affect respiratory health, be given special consideration in this effort. We have not heard from the Air Resources Board yet on our legislative proposal and I am sort of eager to get a response. But we are encouraged. We think it is possible within three years to be able to develop a forecasting tool for $PM_{2.5}$, at least region-by-region, with Sacramento being the first as sort of the pilot project. My understanding, and Mel can correct me, is that South Coast has had a semblance of a forecasting system for PM_{10}, but I have not discussed the issue with him to determine how accurately they feel that system works.

Q: I would like to address this to either Cathy (WSPA) or Cindy (CCEEB). Are there any plans or thoughts about assisting in the development of the technologies, using the tremendous resources of the non-governmental community, to measure the very same parameters that we have stated that we could use and you have stated that you would like us to get?

A: Steve Ziman (Chevron): Yes. I think there are many programs that API is carrying out right now, looking at combustion sources and trying to characterize those for organic aerosol; API, in combination with CRC, looking at automotive exhaust; WSPA and some of its companies working with DOE, because DOE has an initiative to work with oil and gas industry; and we are seeking funds right now for additional work in the San Joaquin Valley under the Central California PM Study. We are going to seek other work there. We have, at Chevron, a project with Sandia where we are again trying to look at real-time measurements of our combustion sources for organic aerosols, for all aerosols both in stack and out of stack. And we intend to share all of this information. In addition to that, again, on other areas with modeling, API has supported, and it's now a public document, an assessment of air quality models for $PM_{2.5}$. It's a huge document, and we have an ongoing project with the same consultant to look at what is needed to evaluate these models, both in terms of PM fine and in visibility. So there is a significant amount of work being done. A lot of it's being done at the national level through American Petroleum Institute and CRC.

Dr. Richard Scheffe (U.S. EPA): From my perspective, the contributions to the research efforts and development from industry as a whole is probably equal to that of the government sector right now. I think CARB actually supports an awful lot of excellent research. I think there is also a degree of focus that industry brings. From what I see there is a heck of a lot research happening. A lot of Susanne's work has been sponsored by EPRI, or CRC anyway. A lot of the research that CARB sponsors is extremely well focused. I think that a lot of research U.S. EPA sponsors is much more diffuse and the time frames are much longer than what you see coming out of industry and state resources like CARB.

Cathy Reheis (WSPA): In addition to what Steve (Ziman) was noting, I think the focus of the question was on technology. I do think that is an area that we are just beginning to get into as an industry and doing some of the joint research that Steve's referring to with the Department of Energy and others. But obviously, we have been at the table on a lot of the efforts that you heard about yesterday in the special studies area where we have looked a lot more at the atmospheric side of the equation and kind of what is happening out there versus the technology to really measure it. So I think that is a new area for us and we are very interested in looking into those research needs. We actually have a meeting scheduled with the ARB coming up shortly to look at some of those opportunities for us to pool our resources in those research areas. We are hoping that bears some fruit as well.

Dr. Susanne Hering (ADI): In special measurements studies, I think that often, at least heretofore, what has happened is that the people say 'Well, we need such and such measurements, and we want to go in the field in two months, or three months, or six months, and it has to be with proven technology. So, that kind of time schedule and the requirement that all special studies field measurements be done with proven technologies holds back, and actually has greatly slowed, the technological development of the continuous measurement method that we have heard a plea for in the last two days. And so, I think there will be a need to directly look at, up front, the technology development.

Dr. Richard Scheffe (U.S. EPA): Because particulate matter is so complicated, I do not think there are any real proven technologies. So, I think the door is really open to do much more of that exploratory work on common platforms.

PM2.5 Expert Panel Roundtable

General Comments

Dr. Robert Farber, Southern California Edison (SCE), (**no overheads**):

- Observations were made on the $PM_{2.5}$ monitoring program both from an Urban and Rural Setting
- Continuous monitors are OK, but need good comparisons between methods
- How are we going to conduct organics shoot-outs? What are reference species?
- Characterization of species is important to oxidation
- Urban studies need to include IMPROVE samplers
- Expand aerosol sampling for visibility (need standards and method techniques)

Dennis Fitz, College of Engineering, Center for Environmental Research and Technology (CE-CERT), University of California at Riverside, (**no overheads**):

- Need to make measurements and then and only then can you get into regulations
- Are we measuring the right thing?
- A lot more research needs to be done

Dr. Pradeep Saxena, Electric Power Research Institute (EPRI), (**no overheads**):

- Nitrate sampling can be done - promising results from SCOS '97
- Studies show nitrate loses from Teflon filters as high as $4\mu g/m^3$
- Organic carbon results have been under estimated - samplers need to be fine tuned and denuders should be used for organics as well
- Organic speciation needs more work

- Need to measure both gas and particle phase of nitrates and organic carbon
- Need to measure total aerosols during PM studies
- Don't use single quartz filters for organics
- Use denuders for both organics and inorganics
- Shift to continuous methods as they come on line
- Use consistent protocols for sampling and analysis
- Speciate organics
- Measure surface and upper air meteorology for modeling and transport purposes
- Measure concentrations aloft

Expert Panel Q & A

General Comments

Q: NONE

Health Studies Presentations

Dr. Steve Colome, Integrated Environmental Services (IES), (**no overheads**):

- Exposure Model looks at: sources, transport, ambient air quality, activity pattern, exposure, ventilation, dose, damage, health status, etc.
- Epidemiological studies over 10 years brought new NAAQS
- Ambient air quality measures are NOT good measures of health effects
  - need information regarding dose for impacts of exposure
  - need to get as far down (on the exposure model) as possible to get dosage
- Need continuity and flexibility
  - mobile, short-term
  - focus on source contribution, intensive health study

Dr. Tom Cahill, UCD, (**no overheads**):

- Southeastern U.S. Visibility Study (Great Smoky Mtns)
  - sulfate was found in sulfuric acid state
  - particulates were found bound to water
- UCSF study/report
  - overlaps mortality/morbidity reports with air monitoring data
  - cardiac mortality found to have high correlation with PM - low in Northern CA and high in Southern CA and Central Valley

Fred Lurmann, Sonoma Technology Incorporated (STI), (**no overheads**):

- What's working and not working in epidemiological studies
- Cannot monitor for just one pollutant
- Kaiser Study
  - needs daily data
  - health data base linked to SCAQMD PTEP data base
- A Children's Health Study is being conducted
  - looking at seasonal and annual averages

- looking at ions and PM
- is more reliable than TEOM, calibrated against hi-vol
- looking at total exposure of children
- helps build models of exposure for individual health status

• ASOS data (Federal Aviation Administration program)

- 600 automated visibility instruments (nephelometer) at airports
- data: archived, 1-minute averages
- highly correlated to $PM_{2.5}$
- good area for health studies

Health Studies Q & A

Q: Jeff Cook (ARB): My question has to do with where we, in the monitoring community, ought to place our efforts for some of the types of samplers that are emerging. One of the things that I have not heard, but there has been reference to, is the availability of some types of standards to do calibrations on some of these kinds of instruments. I know that means going back and defining what some of these things are in the first place, before developing the standards. But when we talk about doing head-to-head comparisons, or we talk about accuracy or something like that, it always comes back to standards. Is it realistic for us to be looking and thinking about, and should we be developing standards for some of these things in order to facilitate the development of some of these instruments?

Dr. John Holmes (ARB): Is there a "gold standard" here, someplace, Susanne? I do not know.

A: Dr. Susanne Hering (ADI): In the mid-'80s there were a number of field comparison studies of measurement methods for different things. There was a comparison of fog samplers to compare the acidity that was measured among different methods. There were comparisons of measurement methods for particle nitrate in nitric acid back in 1985, and in 1986 was the comparison of measurement methods for carbonaceous aerosols. EPRI has recently been conducting comparisons among speciated ionic and carbon samplers among various different methods. These field tests and these field comparisons, I think, are what we really need to decide what are the best field, sort of, "gold standards". A "gold standard" for measuring atmospheric particles is not something that you cook up in your head and then test strictly in the lab. Yes, laboratory tests are necessary, they are important. But, I think it comes down to having to compare things in the field. You get measurement methods that are very different where the collection method is different, and the analysis method is different, yet they yield the same answers. And they yield the same answers under a range of circumstances, a range of temperatures, a range of atmospheric conditions. That gives you a fair amount of confidence that you are measuring the right thing. Not only measuring all the same thing, but it gives you some confidence that it is, in fact, the correct number. And I think we do have, on the basis of these studies, "gold standards" for measuring sulfate, for measuring nitrates, and we are coming closer on the carbonaceous fraction. We can get there for certain species of organic carbon, certain PAHs, or whatever. When we can hang onto a specific organic species, we can know how to do it (the chemical analysis). But to be able to measure all of the organic component, right now, and say this is all of the organic carbon, we are not there yet. I also think, ironically, one of the ones that we are not very close on is mass. So, we have just a functional definition of mass now, but how that relates to the non-water mass of suspended airborne particles is a difficult thing even to define theoretically much less to measure. I guess the bottom line is there has been a number of field studies in

the past and there are still some going on to try to answer these questions. I think that is really the only way it can be done.

Dr. Tom Cahill (UCD): The Air Resources Board really pioneered this effort. Those studies in the '80s defined basically what the approved network is now. Those really were state-of-the-art, and Susanne ran them, too. I remember the driving rain storms and so on. I think that the concept of the super site should have part of this built into it. I think that is a wonderful case. But I think it may also be time to seriously consider some of these really difficult species like mass and organics. I know it sounds stupid but mass is the toughest thing we ever measure. Maybe it's time again to have a situation where with enough forewarning--six months, nine months, a year in advance--at this place and this time, you should bring your best shot. Because also it opens up, as Susanne says, some innovative techniques which take a long lead time. These things do not happen overnight. The great advantages of these open comparisons, new technology running side-by-side with well-tested technology, is a great big flat surface, some data handling, encouragement, and a little money now and then. But I think it might be time, at this point when things are getting so much more complex than they were 13 years ago, with the speciation in particular, to have officially sanctioned efforts to try to make these technologies available to people. These sanctioned efforts should not occur just in Southern California, but in two or three places around the country where the conditions are very different--one winter, one summer, eastern, and western. My own feeling is that filters, which are so easy to use, are so incredibly complex in what they do and how they do it. In the long run I, personally, am going more and more to impaction, or to single particle stuff. I know this is hard because we usually love filters but they make major changes in what you collect. As you move into speciated organics, which we are doing more and more of, the changes they are making are getting harder and harder and harder to understand. Therefore, it might be the right time to have a study where you have the best filter techniques, some of the impaction techniques, and the single particle techniques like Kimberly's, run side-by-side, and save us much grief in the upcoming years.

Dennis Fitz (CE-CERT): What this is all leading to is, really quality assurance in a way, and if we cannot measure it with a "gold standard" then at least, we ought to shoot for consistency. There could be ways we could have one standard, even though we know there are limitations to it, brought to various groups within the country. So at least we are measuring the same thing consistently. So let us not forget quality assurance.

Q: Mel Zeldin (SCAQMD): Steve, I appreciated that diagram you put up. It kind of puts things in perspective. My question is to any one of the three, or all of you. Focusing on the ambient data from a health studies perspective, if you could have your wish list for the perfect ambient data set, what would it look like? I mean, how many years, what sort of frequency, if you could give us an idea of what the perfect set would look like?

A: Dr. Steve Colome, University of California at Los Angeles (UCLA): I will make an initial stab. Your question cannot be answered, because first you have to address what kind of health study you are talking about. So, trying to be a little more specific to what you are saying, if one is dealing with a daily outcome, hospitalizations or mortality, in effect you may not need that much historic information. You are going to need ambient information that is collected on, at least a daily basis. If you can get it on more of a real-time basis, then you can use other parameters like daily maximum as inputs to your modeling. With that framework that I put up, if you are relying strictly on ambient data, what you would want to do is deal with components that come primarily from outdoor or ambient origin and do not have an

enormous amount of contribution from near field local sources. Cross-sectionally, if you are dealing with multiple communities, there are other things you would consider in addition. I do not know if that partially answers your question but others will probably want to address this.

Fred Lurmann (STI): I want to add a couple things to that. It would be ideal to have one where the sampling was really population-weighted, if we are talking about a general purpose data set for the long run. Also, one that had sufficient spatial resolution so that it actually captured communities with different pollutant profiles. The only way in a health study that you are going to be able to distinguish associations between just air pollution and health, as opposed to certain species and health, is to find communities that have different mixes of profiles. High elevation communities, generally, have low PM compared to ozone. Source regions have low ozone compared, sometimes, to PM and NO_2. I think the ideal network would be one that would have a good range of pollutant profiles so that the health study could take full advantage of those differences in trying to sort out which pollutants were responsible for the health effects.

Q: Earl Withycombe (ALA): In trying to associate the comments of both Tom and Fred, Fred I have a question. Tom said that we have a fair amount of data here in California. I am intrigued by that. I participated with him in trying to develop additional data to add to what you were generating for the Kaiser Study in northern California. And I am struck by your comment about what a robust data set you found in southern California, and I am wondering whether the gaps in the northern California effort were more of a temporal, geographic, or chemical nature?

A: Fred Lurmann (STI): Temporal. I mean the biggest problem we have with historical PM data for health studies in California is that 98% of the data is collected on a once-every-six day basis. If you are trying to look at a time series, data gaps are very difficult to deal with. The five-out-of-six day data gap is a very large short-coming. It's really only during the special studies that we have this daily data in California, other than in some places like the Bay Area where there is a coefficient of haze network that is highly correlated with $PM_{2.5}$ and PM_{10}. It's been used quite successfully in some PM mortality studies. But, the real short-coming is just temporal. It's not frequent enough to be able to associate it with daily hospital admissions, emergency room visits for people with cardiovascular problems or kids with asthma, and so forth.

Q: Earl Withycombe (ALA): Have you found nephelometer and COH networks outside the Bay Area?

A: Fred Lurmann (STI): The Bay Area's is quite extensive. Los Angeles has two nephelometers and two coefficient of haze monitors running consistently, which is not enough to characterize PM exposure for 12 million people. It's just not enough. It's spatial.

Dr. Tom Cahill (UCD): Earl, I had a comment. One of my graduate students at Sac State, named David Lipnick, working with the Lung Association group, did use the COH measurements in Sacramento, some of the existing TEOM data, and the one-day-in-six sampling data. He was able to splice together a pretty good daily data set, rather good in winter, poorer in summer. But the point was that these targets of opportunity are already there (his thesis actually has a series of algorithms that allows you to come up with something). It was, in fact, for Kaiser Permanente. They were just generating it. So, these things are all kind of linked. But you are quite right, the one-day-in-six is a real monster. But you know, it's surprising that when you use the existing COH data, even if you are not totally accurate on a daily basis,

very large spikes which are otherwise totally missed are picked up. Trends come where you will have three or four bad days, and then, just as the bad days go away, you measure your one-in-six day and the next day the hospital admissions are sky high, based upon the previous three or four days that you missed. So, even with that kind of effort, and I love the idea of your airport monitors too, you can patch something together.

Dennis Fitz (CE-CERT): I would like to extend that just a little bit. We are thinking about the ideal network and the time variable. A lot of people sample from midnight to midnight. That is just the worst possible time as far as artifacts. It does not help you find what direction it's coming from. Maybe we need directional sampling. Because if you look back at the sources with a 24-hour sample and four hours came from one direction, you will never see it. So, maybe we should get away from the rigid "from one time to the next time", the midnight-to-midnight, and look at alternatives. Midnight-to-midnight was easy. It's not giving us the best information.

Helene Margolis (ARB): I would like to add one comment to this in terms of what do we need for the network for the future. Regarding health effects with respect to the long-term health effects, or the health effects that occur over periods of years, we do not know whether it is a function of the short-term, high concentration exposures or the long-term moderate, low-to-moderate levels. The Children's Health Study will begin to answer some of these questions, but it's not the definitive study, per se. I can see a number of years into the future where the network is going to need to increase the temporal quality of the data, where we have more frequent measurements, better speciated. It will be a number of years before we can answer some of these fundamental questions, in terms of the hourly measurements and the daily measurements. Then we can use different summation metrics to assess the impact on different health outcomes, not just frequency of asthma but in terms of development of asthma over periods of years.

Jeff Cook (ARB): John, can I just make one comment? This is coming from the monitoring network point of view. I think that we are oftentimes fairly removed from the health people, and in trying to design networks, there often times is not a very good connection between the two disciplines. For example, as we were just setting out to design these networks for the federal regulation, there were people of the assumption that it was not prudent to go out, and it was not cost-effective, to collect daily data if you did not have a study already planned. Now we are hearing that you can do stuff in arrears, and a lot of studies in fact are done with data that has been collected, so that is not necessarily a criteria. The challenge for us, because we have to try to serve many masters--we have the regulatory part, the compliance part, the health part, and so forth--is how to make this cost-effective. We are hearing daily sampling, and maybe the way to do this is to optimize this in the high times. That is one of the things that we have heard. We have heard that, perhaps, you do not need the specific mass numbers that a good surrogate, on a daily basis, is all that is necessary in order to lend support to that. It's really more of a comment than anything, but we are trying to develop something that is cost-effective, that gives as many of our masters information as we can possibly get. That is a true challenge for us. We are hearing some good stuff here today, I think, that will help us go forward, at least with sampling frequency, if not spatial representativeness and so forth. But things like optimizing daily sampling at high times and using surrogates, if I am reading this right, are things that we can take from this for the health studies.

Steve Ziman (Chevron): To go back to what Fred Lurmann said in the beginning here in talking about this, we want to really know and understand exposure. We are going to try to develop exposure models

along the way, because that is what we are probably going to use as we start to look beyond just reducing total loading to understanding what we are reducing, and understanding also what is going on between indoor and outdoor. I think, in some respects, we would like to go into some of these very sophisticated and cost-effective methods. But in the interim, we may well have to put a lot of money into a few programs. We may have to take a tremendous amount of costly measurements where we are looking at impaction, size speciation and speciation of each of those size fractions itself in order to understand. Then, we have--and I hope we do have them--health chamber studies, as well as epidemiological studies, to understand what we need to aim at once we start to understand the health effects relationships and causality. So, I do not see a real simple route. I think for a little while we are going to spend a lot of money, if we do this right, to try to characterize the relationship between indoor and outdoor, and indoor and personal. We are just going to have to bite the bullet on that one. There has been some work done. I think in Nashville Petros Koutrakis has done some work, and also Boston, and there is some more work going on, but not enough work to really do the characterization that is needed.

Q: Dr. John Holmes (ARB): So basically, Steve, you are saying that for at least the next five years or so, to design and deploy a network that would be in effect, all things to all people, would be a futile effort. We ought to just keep doing specialized studies for health or modeling, or whatever, until something far more sophisticated comes along?

A: Steve Ziman (Chevron): It's a combination of both of them. I am not saying give up. On some of these things, in order to do the chamber studies and the epidemiological studies really well, right now you need the data and you have to go to things that may be real costly but will get us some of the data that we need. People may have to go with Moodies indoors and then look at those filters and figure out, actually, how to get measurements out of those and how to speciate those. These are real difficult things to do. Glen Cass has pushed the limit in some of the things with regard to looking at organic aerosol speciation. It's not routine, John, at all. But I think for the time being we are going to have to bite that bullet and go with it as we develop the other things.

Dr. Pradeep Saxena (EPRI): Just a couple of things. I think that is a really good point that Steve made. In fact, I have the data from the Nashville study that Koutrakis did show outdoor versus indoor, interpersonal, with no correlation. Also, I wanted to get back to what Tom said. I think having a shootout on organic speciation and on continuous methods is a real important thing to do. We are thinking about that. I think that U.S. EPA, ARB, DOE, CRC, and EPRI should take the lead on it. Give some people in the lab time to get their methods in order, then go out to different places, maybe South Coast and other places, and do it in the next 24 months.

Dr. Tom Cahill (UCD): One comment. The one thing we found from the urban studies in the Sacramento Valley was big gradients in $PM_{2.5}$ in terms of amount, but the compositional changes were much less. So it's an interesting thing about having a single station in the center of a network that does a really good job at a lot of stuff, and then having simpler stations, either in frequency or time, dispersed throughout the network. I think that concept does have a lot of validity based on what we have seen now. You often see that the aerosol stays rather similar in composition, but the amount drops very sharply. In which case, you could use some of the very cheap surrogates to get you more coverage and save some of your fire for the pretty vital measurements that have to be made, maybe can afford to make, at one site in a central city.

Dr. Walter John (PSci): Just to follow up on that. I think that maybe the State should consider not waiting for U.S. EPA but establishing its own super site or super sites to get a start. At a super site you would speciate just as much as you can, in other words HPLC, GC/MS, whatever tools we have that get us all the components. And to have, at least in the major areas like Los Angeles, a catalog of everything that is there. I am a little concerned that we are going to monitor the usual suspects and miss the active component. We have no idea. The medical people are just at sea. They have no clue as to the causative agents. So, I think that intensive monitoring is important.

Dr. John Holmes (ARB): That is a very interesting idea. A central site which is a super site and then, I do not know what you would call it, a semi-super site. To some extent this would get around the resource restraints that we have talked about. Make a note of that.

Dr. Susanne Hering (ADI): I would like to add to what Walter, Pradeep, and a number of other people here have said. We do need these special studies with the measurements using, essentially, all of our capability that we can. At the same time, we have to take a guess at measurements that would also serve in the monitoring mode in the future. If we are to move to continuous measurement methods in the future, those methods need to be bench marked against the best measurement technology we have. Doing that at a super site, where you are measuring with all your capabilities all the things that you can, makes a lot of sense. That would build a bridge for the future monitoring needs as well.

Dr. Walter John (PSci): The super site could also be a place where you invite people to try out their latest continuous monitor.

Q: Dr. John Holmes (ARB): A place for shootouts and that sort of thing?

A: Dr. Walter John (PSci): Yes. It's better than a shootout because a shootout is a temporary location and it only happens over two weeks, or whatever. A super site would be in continuous operation. Some things would continue to operate all the time, but people would come and go with their special samplers. That way we would have a lot of data on evolving technologies.

Dr. Lowell Ashbaugh (UCD): Walter, I would like to second that. I would not limit it to just continuous methodologies, but other evolving technologies that would use 24-hour based filter sampling, for example, and new analytical techniques.

Dr. Walter John (PSci): I guess my frustration is that we are now speciating the polar regions of the moon and the surface of Mars, and we cannot do the job out here on the street. It's a question of resources, mainly, and the fact that we are basically low tech. We have not really brought modern technology to bear on our problem.

Dr. Eric Fujita (DRI): The benefit of this concept is that some preliminary analysis could begin in the near future. Some priorities could be set as to what components buy you the most in terms of what is going on in the atmosphere. That would be the main benefit.

Q: Dr. Richard Scheffe (U.S. EPA): I guess I do not hear through the same filters that Jeff Cook hears through. I am at a loss. I have heard a lot of different messages. For instance, with continuous monitoring, I have heard on the one hand we need continuous monitoring and on the other hand maybe

we ought to do integrated bi-weekly sampling. I have heard that the FRMs do not really help the health community, but U.S. EPA uses the health community as a reason for using the FRM. I have heard fewer sites. I have heard more sites. I have heard let us not use filters and let us use continuous methods. But, I have heard let us use filters because we need to archive and do retrospective analyses later. I have heard people versus population. I do really think we want it all. I think one thing I have heard is the need for redundant techniques. I know Tom actually did not mention that, but that is one of Tom's pet phrases and the IMPROVE program uses that quite a bit. And I think that is where Susanne is coming from because there are not standards for what we are trying to get at. One other thing, the way I see it, there are an awful lot of commonalities between what the health community needs and the atmospheric science or the modeling community needs. But, it might start to be easier to focus on where we do not have common overlaps. One area is in terms of elevated measurements. I do not think the health community really cares what is up in the sky, but I think the modelers really care because, if you do a mass balance, most of what you have is pretty high up there. That is what we learn from all the ozone studies. So, we have a little bit of an area here where we can define something that is not a common basis. I am a monitoring person. I believe in observations. I do not know if I really believe in the models but, sort of, I do. We want things at different kinds of averages in terms of either space or time or chemical composition. Since we want everything, can we someday use the model outputs and the greatest surrogates we were talking about as a predictive measure from these models? Can we use these in the health studies? Can they be incorporated after we do enough of the characterization in the atmosphere so that we have some confidence in the models, and then use the models to go back retrospectively and compare them to hospital admissions, and so forth? I just want to throw that out as another circuit.

A: Dr. Steve Colome (UCLA): I will try first stab at that. There is no tradition to what you are suggesting, but it's a great idea. There is every reason why model outputs could be inputs for exposure on health studies.

Dr. Mark Jacobson (Stanford): I will just quickly comment that you can use model outputs, but what you really need to validate the models and to initialize the models are a lot of data to get them going.

Dr. Richard Scheffe (U.S. EPA): That is where I am coming from in terms of trying to design and trying to reach some economies in designing a monitoring program. Maybe we can design a monitoring program that really characterizes the atmosphere that leads to model evaluation. Then we have confidence that the models are working. That is where I was coming from.

Dr. Mark Jacobson (Stanford): I think we will discuss that a little later in the modeling session.

Dr. Robert Farber (SCE): John, I had a comment out of a sense of frustration responding to several of these people here. I have been particularly frustrated as an interested bystander in the CASAC go-around that just occurred, the problems associated with the goings-on with the Harvard Six-cities study, and the re-analysis, and the questions of that. But I think one of the bottom lines of that is germane to the discussion today. During that study, evidently there were, from a monitoring perspective, key components missing in the atmosphere which the health people were not getting that have to do with the causative agent. Of course, that is all going to go under review again in the next few years, and in the next go around. I think one of the things that we need to address, and this is where I think this is somewhat different in terms of the health perspective from the ambient air quality, is this business about

what exactly is it that we need to address, the health questions, so that we do not repeat this go-around again that we had with the infamous Harvard Six-cities studies. What is that going to take? This, I think, is something that was echoed by several of the people at the Long Beach $PM_{2.5}$ conference. I think some people suggested that the health people get together, in the next few months or so, with the monitoring people and have a workshop to see exactly what is needed for this next go-around and to have a master plan. To me that is a little bit different than a kind of routine ambient air monitoring network. I think there are going to be some different things needed for that. So, just before we left the health thing, I wanted to point that out. I think that is important.

Dr. Richard Scheffe (U.S. EPA): One comment too about Jeff's point regarding economizing the work. If you let the regulatory agencies just go and do their thing, they are not going to be overly responsive to the needs out there. That is why these kinds of forums and this kind of interaction is just so darn important. That is one of the things that both Jeff and I are trying to do from our respective roles, him from the State and me from the federal level, to try to make sure that we are doing more than just measuring for mass and checking for compliance.

Dr. John Holmes (ARB): I am going to have to cut it off there. This is a very interesting discussion and it went on for one hour, nearly one hour, instead of the scheduled half-hour. I am very pleased with how it went. A lot of things are out on the table and that is why we are here. Even though they seem to be contradictory, we can work our way through it.

Public Notification and Forecasting Presentations

Dr. Lowell Ashbaugh, UCD, (**no overheads**) :

- Need real time air quality data which should come into a central location
- ARB already has a program like this with agricultural burn - this type of forecasting can be done with PM also
- Another useful tool is a remote sensing lidar which could give a forecast needed for public notification
- Particle monitors may not be able to give us real time data

Dr. Robert Farber, SCE, (**no overheads**):

- Forecasting is available - NOAA decided to make its research more real-time and available (forecasted El Nino 9 months ago)
- NOAA is gearing up to provide rain and high wind forecasts using climate models with a lead time from 7 - 10 days to several months (focus is on long term forecasting)
- With NOAA we can get longer forecasts for special studies (e.g., hotter than normal summer, etc.)
- Need to use NOAA for forecasting air quality - this could save money

Mel Zeldin, SCAQMD, (**no overheads**):

- The ability to use predictive models for notification is available - its been done before and can be done again
- The methods are data driven (e.g., in the South Coast we know what conditions lead to high concentrations, etc.)

- Take weather variables and turn them into some relationship correlation that gives an estimate that can be used for a $PM_{2.5}$ notification - (this might be crude and might predict high $PM_{2.5}$ and even if it does not occur, predictions will get better with time)
- In the South Coast for example, different stations show different air quality patterns; therefore, the cause of the behavior needs to be understood before forecasting can be done. If profiles can be used to predict high winds, then predictions can probably be made. The capability for forecasting is available
- A system can be developed to make public notifications, but it may be crude in the early stages

Public Notification and Forecasting Q & A

Q: Dr. John Holmes (ARB): Mel, you say the PM_{10} forecasts are less accurate, less reliable than ozone. Is that just a matter of gaining experience or does one need to divide the basin up into smaller zones?

A: Mel Zeldin (SCAQMD): Part of the difficulty is that we are dealing with a 24-hour value and the meteorology could be changing during that 24-hour period. It may start off in the direction that you forecast but, because meteorology is changing, the last half of the day or the last third of the day may do something different, and you do not see as accurate a forecast. I think the record is pretty good that, if you are looking for elevated levels, you can predict those days that are going to have elevated levels. It's just the degree to that sort of elevation whether you are near the standard, or 75% of the standard, or 50% of the standard on a given day, or over the standard. You can come pretty close I think to showing, let us say, that it's going to be above 50% of the standard. But whether it goes to 100% or 120%, that is where it gets a little vague. I think it's clear to say that if you were down at 10% or 20% of the standard on that day you can readily identify that, and if it's going to be elevated you can identify that. It would help, I think, for us to pay a little bit more attention to understanding the phenomenologies of the diurnal effects of a particular area and at least try and hypothesize what factors are contributing to that sort of diurnal profile. When you understand that, I think the meteorologists can piece some of that together in terms of what sorts of meteorological factors are having a bearing on that. So, you put the right combination of meteorological variables in the development of your predictive models. One of the difficulties we face is that the number of potential meteorological variables is virtually infinite. While you have certain measurements, you create other variables from variables such as pressure gradients where you take differences from one station to another, 24-hour pressure changes, changes in predictive conditions aloft, or the temperature at 850 millibars from one day to the next. You literally can create an infinite number of variables but the variables in those changes, generally, are related to some sort of phenomenology. It's our job to try to better understand those phenomenologies to help improve the forecast. I think we are on the right track. I think any area that has any sort of data and any sort of cognizance can get started on that. We can only improve in the future.

Dr. Robert Farber (SCE): Just one comment, Mel, to what you were saying that may help improve the accuracy as time goes on. Not only do more continuous measurements of particulate matter improve the accuracy, but also, since they are closely related to the ambient conditions from a meteorological perspective, now for the first time we have more continuous meteorological measurements. In the past we have had snapshots. We have had upper air snapshots at one or two locations. You take them at five or six in the morning and you take one more in the afternoon. What we may find, as time goes on, is that what we really need for a better understanding to give us the key parameters may be something that happened at ten in the morning or something that happened at three in the afternoon, and maybe a better

temperature level than what we are using now. So, not only are we now entering the era of continuous ambient air quality measurements, we are also entering the era of continuous meteorological measurements. They have already shown us an incredible window into the behavior of the atmosphere that we were not aware of before. My feeling is that, as we start to incorporate the continuous meteorological information into these clever empirical models that Mel's been working on for a long time, in fact, the predictions can only improve. I am optimistic.

Q: Earl Withycombe (ALA): Mel, do you think it would be an easier task to develop a predictive forecasting model for $PM_{2.5}$? I suspect, correct me if I am wrong, you get less geographical distribution in $PM_{2.5}$ than you do in PM_{10}.

A: Mel Zeldin (SCAQMD): I think it may be easier because it reduces the dust component. I think the dust component is fairly localized and often difficult to parameterize with meteorological conditions. When the desert blows, I think, you can have a pretty good handle on that. But you can get localized effects, winds perhaps, near some sites where there were some extra agricultural activities in San Joaquin, or in South Coast where there was some wheat clearing at a lot near a monitoring site when winds come up and affect the crustal component. That is almost impossible to forecast. So, when you eliminate that portion and go to the $PM_{2.5}$ which is minus that real localized effect, it becomes more regional. You are dealing with a lot of secondaries. You understand the meteorology associated with the conditions favorable to those processes. What you are saying is probably correct. Given enough $PM_{2.5}$ data, in time, I believe our abilities to predict $PM_{2.5}$ may, in fact, be better than our best abilities to predict PM_{10}.

Q: Dr. John Holmes (ARB): Are they beginning to develop an empirical model that would be able to do that (forecast $PM_{2.5}$)?

A: Mel Zeldin (SCAQMD): For $PM_{2.5}$? In South Coast we are using our '95 PTEP data base to already start work on doing $PM_{2.5}$ forecasting. I believe there is a bill currently, I forget the number--I believe it's by Senator Hayden--that would require South Coast to provide $PM_{2.5}$ forecasts to the public. We may be legislated into doing that, so we are already starting on that path. I would hope that we would have some preliminary capability to test this out by this summer.

Q: Dr. John Holmes (ARB): What are the prospects for other districts being able to do this sort of thing? I mean, we have fog forecasts which seem to be right maybe half the time. Not quite the same thing, I suppose.

A: Mel Zeldin (SCAQMD): I think the capability is good. Whether you look at San Joaquin, whether you look at Sacramento, as long as you know you have a pretty good idea of what types of conditions lead to the high events, the elevated events, you can parameterize that. Given skilled individuals that have the ability to put into the computer the right combination of parameters, you can come out with something decent, and you can do it in a fairly short period of time. It does not take a lot of time to do that.

Avi Okin (BAAQMD): Just one comment. There is a fine component, $PM_{2.5}$, in wood smoke. We have used our COH network to get some of the parameters, meteorologies and such. We put those together. Our parameters come up in the first eight hours of the day in the overnight because we know that: one, people are most likely to burn in their fireplaces in the evening, and they are not going to burn during the day; and two, the strongest part of the inversion in the Bay Area is on the overnight area. So, we have a

program we call "Don't Light Tonight." We do that at 10:00 in the morning. We put out a forecast. You can get it out to the news media pretty quickly, asking people not to use their fireplaces, but rather to use either gas fireplaces or just do not burn that particular night. We are aiming at this one component, the wood smoke component. So, there is a program in place, and I am sure others can develop a more succinct, or even a more sophisticated, model. But this is something that we have developed and it seems to be working pretty well.

Special Studies versus Standing Air Monitoring Networks Presentations

Dr. Susanne Hering, Aerosol Dynamics Incorporated (ADI), (**no overheads**):

- A number of special studies have been conducted over last three decades
- Added motivation for future studies - put in basis for health effects
- Labor costs are very expensive and difficult to maintain long-term
- Need for continuous, automated system - must be tested and field demonstrated
- Particle number concentration was dropped from past studies but could be useful
- Need to look at needs for future health studies and monitoring - they need to be coupled
- Support super site to establish and use as benchmark
- Long-term studies need to use continuous methods
- Short-term studies can be conducted through "shoot-outs"
- In planning special studies, it's important to have public forums such as today
- The educational aspect of these studies is enormous as compared to measurement and transport aspects

Dr. Walter John, Particle Science (Psci), (**no overheads**):

- A lot of consensus for continuous monitors
- No one is excited about FRM samplers
- Need a tie between research and monitoring
- Research emphasis should be on health, otherwise controls would be ineffective
- No substitute for side-by-side monitoring/testing
- Filter equilibration requirements need to be addressed once and for all (humidity problem)
- Build super sites incrementally
- Two kinds of studies: outside and inside
- Speciation capabilities are needed
- ARB role: facilities, platform, space

Dennis Fitz, CE-CERT, (**no overheads**):

- Agrees with super sites
- Need to integrate special studies with routine monitoring
- What is up in the air is different than at ground level
- We are dealing with organic artifacts
- In the South Coast, up to 50% of PM is organics
- A lot of what is measured in PAMS is precursor to PM
- Educational component of special studies is also important

Dr. Lowell Ashbaugh, UCD, (**no overheads**):

- Likes the super site concept - it allows for comparisons at any time

- Important to define super site objectives:
  - monitoring and regulatory requirements
  - needed information (e.g., source identification for transport)
  - health effects - resolution, space, working environment
  - model development - mass, size, precursors
- Other needs - upper air, lidar, continuous, PM and ozone help with transport
- We do not have the ability to identify organic speciation
- Need to put to rest idea of difference with TEOM, BAM and humidity equilibration
- U.C. Davis is conducting filter equilibration studies to look at losses from filters due to varying temperature and relative humidity conditions
- Cannot neglect visibility
- Sampling platform for ozone is needed
- Long-term monitoring of whatever we can do now (core of samplers)

Special Studies versus Standing Air Monitoring Networks Q & A

Q: Dr. John Holmes (ARB): What is a super site and how much would it cost?

A: Dr. Walter John (PSci): Build the super site incrementally. For example, start out with just a regular air monitoring site except that the filters are analyzed in a laboratory with various spectrometers for a wide spectrum of results. Then gradually work in all the other advanced samplers. If need be, cut back on a few routine monitoring stations.

Dr. Tom Cahill (UCD): Someone mentioned having the super sites run continuously. I think it's important to have, at certain times, periods where you encourage people with similar types of measurements to be there side-by-side. Otherwise, you have some with a new technique comparing against a standard technique. The strength of the shoot-outs in Los Angeles was that everyone was arriving over a two-week period. That combined with a continuous record is a powerful tool. In some ways all you need is a flat platform, enough power, access, and control of data by an independent party. It seems to me that we could find three or four places for super sites--one in Kern County and two in Los Angeles. Start out with a particular problem area (e.g., organics). Then encourage everyone to be there during a two-week period in the summer. Many of them will come with their own money because they want to test their new equipment. Others may need some help, small amounts of money. The point is, setting up a neutral platform for this type of study will result in rapid progress in things that are too chancy to put a lot of money into until you are sure that they work or not.

Dr. Lowell Ashbaugh (UCD): I had a concept of what a super site might look like also. It would be a sampling platform with adequate space and power for anyone to come in and use. Over the long-term, there would be a set of core samplers operated by the ARB, districts, or several agencies. It would include long-term monitoring of whatever we can do right now. Then in addition, we can add side-by-side testing, development of new sampling methods or analytical methods, and development of new continuous methods. There would be a long-term core of samplers that are there ready to be compared to new methods at anytime.

Dr. Walter John (PSci): I think there are two kinds of testing that you might want to do. One requires being outside, so a roof top facility would be needed. The other would be inside and use spectrometer-

type instruments that need a more benign environment. The goal is to speciate the samples; therefore, you would only need a pipe coming down from outside and the rest would be inside. The role that ARB would have is to supply power and a place to operate temporary facilities for visitors.

Dennis Fitz (CE-CERT): Extending that further, I would like to see an educational component also. Too often with these special studies we have a lot of researchers come together that are busy 100 percent of the time with their own research and are not able to learn what other people are doing. If we had a centralized area with maybe some classes and seminars, everyone could learn more about what is out there. Right now dissemination takes a while. You have to wait for it to come out in a publication. It is not the same as doing it hands-on and seeing the data right there as is the case with some of the continuous analyzers.

Dr. Susanne Hering (ADI): The idea of the super site is something Dr. Walter John and I discussed a year ago and brought to ARB at that time. What we had in mind was a site that had a long-term component that emphasized some of the continuous methods because they are easier to keep running on a long-term basis. A short-term component would consist of intensive shoot-outs. This would allow you to build up gradually the long-term component on the basis of the results of the short-term aspects. I think that in terms of education, there are a couple of things. In planning one of these studies, it is important to have an open forum or workshop similar to what we are having here today. Then people with ideas would have a chance to come forward and present what they need. The needs of the health effects and monitoring people need to be coupled together. We need to target what methods are going to be developed. We need to measure what is capable of being measured and get ideas on how to measure things once it is known that there is a need to measure them. Therefore, it is important to bring all these people together in a planning process for this. Likewise, the education of watching everything out there on the platforms is better than any conference because you can see everything firsthand. The educational advantage for a single site study as opposed to a distributed study is enormous. You do not gain any knowledge about transport, but you gain a great deal of knowledge about the measurement methods. In terms of tying it with health effects, the single site may be expanded to a second site.

Dr. Richard Scheffe (U.S. EPA): Everything we have heard here about the super sites makes a lot of sense. It can be used as a training/educational site, a long-term site, and also a site for testing many other methods. But do not forget that it is a comprehensive atmospheric chemistry site as well. There are techniques out there that can look at some of the intermediates like the peroxy radicals, hydroxyl radicals, and total peroxides. There are measurement techniques to look for reactive nitrogen components also. All of these are interwoven with the secondary aerosol processes and oxidation processes. We are not talking only about a site that does comparison of methods and gives us a lot more resolved time and spatial information about aerosols. We are also talking of a site that gives us information about all of the formation processes, the maintenance processes, and the termination processes as well. It is a very comprehensive site. The other thing, in talking to a lot of utility people, there is a great opportunity to collaborate with industry who tends to want to put sites in transport locations.

Data Analysis Presentations

Dr. Tom Cahill, UCD, (**no overheads**):

- Need to keep secondary data needs in mind (transport, forecasting, modeling, research, etc.)
- Need better coordination of data sources

- Need ARB studies more readily available to researchers and data analysts
- Want to put IMPROVE data on ARB data set
- Emission inventory data are needed by modelers (1-hour data increments rather than 24-hour integrated numbers)

Dr. Eric Fujita, Desert Research Institute (DRI), (**no overheads**):

- Source apportionment for El Paso indicated certain sources cause certain peaks during the day (e.g., vehicle exhaust - interested in daily trends)
- Continuous data provides a look at longer trends
- Continuous data can also provide source contribution information due to wind directional effects
- Concerning speciation, organic species are needed to look at apportionment
- Once it is determined what species need to be measured and what sort of sampling is needed to get a proportionate measurement, representative profiles can be established
- Motor vehicle emissions should also look at PM and vehicle type (it currently does not)

Dr. Pradeep Saxena, EPRI, (no overheads):

- Fewer sites, but more meaningful data
- Do the best we can with current technology
- Speciation at more sites everyday
- Use of tracers for source contribution is important

Data Analysis Q & A

Q: Dr. Richard Scheffe (U.S. EPA): We have seen how difficult it is to get speciation profiles off of a quartz filter. But it is not so difficult to sample the gas phase through auto GC work or canister work, etc. Have you done combined apportionment analyses where you look at the gas phases and the particle phases and combine those to get source indications?

A: Dr. Eric Fujita (DRI): Yes. We actually did that in the Northern Front Range Air Quality Study in Denver. We did combine the gas phase species and the particulate species to generate a dual phase profile. We included PAHs in the organic speciation. Somewhere in the spectrum of PAHs there was a cross-over from gas phase to particle phase. We also had methoxyphenols which are signatures for wood smoke. We were able to apportion hardwood and softwood. There were also lactones and furans identified. So there are a variety of marker compounds that can be included in the source profile even though together they represent a very small fraction of the total organics. This was a successful study. The draft report was sent out to a peer review panel in January. The actual final report will be released in mid-April. One of the major findings from the study was that gasoline vehicles had a much higher fraction of the fine particle carbon than we had believed. If you look at the emission inventories, diesel is a large fraction. But what we found in this study is that gasoline vehicles are the predominant fraction.

Q: I have a question on the process. We have had a lot of discussion about speciation and adding on. But in the short-term we have a proposal that we are going out with to seek funding to initiate our $PM_{2.5}$ network here in California. The sense that I have is that we hope those monitors are obsolete in two years. One of the suggestions this morning was that it may be prudent to cut back on the frequency or the number of monitors and put those funds into pushing technology forward. What I am asking from

this panel is this: is there consensus that it is a good thing to be looking at how we are allocating out initial funds for our initial monitoring roll-out?

A: Dr. Pradeep Saxena (EPRI): That is a very good point. As Dr. Richard Scheffe said this morning, a lot of the 97 million dollars for this year's budget is going into measuring mass. We all agree this may not be the right thing to do. I support what Mel said and that is to have fewer locations but more meaningful data, if possible. I suggest we do the best we can with the current technology and focus on developing technologies. Maybe we should do more speciation at fewer sites everyday than put out FRMs or other types of monitors.

Jeff Cook (ARB): I would like to direct a question towards Dr. Richard Scheffe as to the practicality of doing something like this. One of the many masters that we serve is trying to get designations made in as many areas of the State as we can, whether they be in attainment or non-attainment. Traditionally, this is the first thing that has to be done. I think that is what the plan at this point is largely set to do. I do not know what kind of flexibility we have in that.

Dr. Richard Scheffe (U.S. EPA): This is a scary question because my interest is much more in the kinds of measurements we talked about today. Let me just preface everything. These were posed as the next steps: What do we do looking into the future? The FRM is the number one priority. There is not any hard and fast science as to how many sites have to be out there. Right now we are looking at coverage and defining what areas might or might not be problem areas. My suggestion was, after we have this monitoring network in place and we find out there are a lot of areas that are not experiencing a problem, we should be in a position to shift resources. That is where it is at right now. This whole issue of balance between mass measurements for compliance versus more diagnostic types of measurements for inside, is a very difficult one. I do not have an answer.

Dr. Susanne Hering (ADI): What we heard from the districts today and yesterday was a request to cut back on the daily sampling. They want to do less sampling, especially during periods when they know that there will not be much, because they say to establish attainment or non-attainment does not require as much sampling. Yet we hear from the health assessment people that you cannot do a time-series analysis without a daily data base. I think that both of these factors push towards having more complete information at a handful of sites where you know you have a problem and where there are people.

Fred Lurmann (STI): I will second that. I really think that, first of all, taking some of the resources and devoting that to instrument development is a critical thing at this point. Everybody here wants a continuous monitor, but they are not there off the shelf. Especially for all the species we are interested in, we are not even close to having something that is operational. That ought to be a good portion of the resources, but it may not be in the plan right now. Secondly, I think we are much better off making high quality measurements, which include daily, at a more limited number of sites. I do not think we will lose a huge amount in terms of attainment designation. Some of the areas that are likely to end up as being non-attainment, may already have 10 or 12 monitors currently assigned in their list. You may be able to get away with fewer of those. You are going to find out that an area is in non-attainment with six or 12 monitors. The attainment designations will have to be determined and mass will have to be done at every site. A better job can be done at fewer sites and still obtain 90 percent of that objective.

Q: Steve Gouze (ARB): Dr. Eric Fujita mentioned pollution roses and Dr. Pradeep Saxena mentioned tracers. Would there be any other suggestions as far as techniques or methods to assess transport of $PM_{2.5}$?

A: Dr. Eric Fujita (DRI): Modeling obviously would be the best way. With descriptive data analysis, what you can often do is look at adjacent sites that have PM data. If you had continuous data, you could see how the diurnal patterns overlap and see the range or zone of similar pollution concentrations in the area. If you see patterns in the diurnal variation that overlap but are offset by certain periods, then you can see that transport is occurring.

Modeling and Emission Inventory Assessment Presentations

Dr. Mark Jacobson, Stanford University (Stanford), (**no overheads**):

- Monitoring needs for modeling - 3D grid-based to initialize model
- Need data to compare model predictions against
- Data only needed, if prognostic model, for initialization
- Need intensive monitoring for modeling profiles
- Visibility is important, but need to look at ultra violet radiation
  - UV affects almost all of photolysis in atmosphere
- Need vertical profile for comparison of primary and secondary organics and concentration
- Remote sensing - untapped capability
- Need emission inventories that are time resolved, etc.

Fred Lurmann, Sonoma Technology, Inc. (STI), (**no overheads**):

- Using 24-hour data for models misses dynamics
- Modelers need time resolved data - 1 hour data increments rather than 24-hour integrated numbers
- Emission inventory needed for modeling
- Need to know size of particles - this does not exist right now
- Ammonia emissions control strategies effectiveness unknown
- PM levels much lower as you go above mixing layer
- Emissions data from about 1/4 to 1/6 of days needed to get a credible annual average

Dr. Pradeep Saxena, EPRI, (**no overheads**):

- Super sites need to look at ozone and PM components relevant to characterization and also look at sources, health, meteorology and visibility altogether
- Should also look at CO, VOCs, NOx, H_2O_2, HNO_3, NH#, particle phase carbon
- Need to speciate organic PM by first focusing on method development and testing
- Particle acidity needs to be looked at for health concerns

Dr. Eric Fujita, DRI, (**no overheads**):

- Need for good emission inventory for fine PM
- Speciation of motor vehicle emissions - organic carbon
- PM Emission factor model numbers are 10 - 15 years behind development of VOC/CO model

Modeling and Emission Inventory Assessment Q & A

Q: We in the regulatory community are becoming aware of the need for UV flux. What efforts are being made for UV flux measurement?

A: Dr. Tom Cahill (UCD): There are nine stations put up by the Department of Commerce around the country to try to get this UV index monitor and U.C. Davis is one of them. One of my graduate students is doing UV flux measurements as part of his Ph.D. thesis. A portable sampler is used to make trends of UV flux across the Sierra. We have seen major changes in UV flux from the valley floor, where it is largely scavenged by the organics, to the Sierra where it becomes sky high around 7,000 feet. We also agree it is one of the forgotten aspects of this business.

Dr. Mark Jacobson (Stanford): I think in these intensive field studies, there should be up to eight UV index measurements. UV flux really varies where you are tremendously and depends a lot on the aerosol loading near you. It is also a good way to test the models.

Q: To Dr. Susanne Hering (ADI): You flew filters and got $PM_{2.5}$ aloft this summer during SCOS. Can we put a price tag on that per filter?

A: Dr. Susanne Hering (ADI): I do not know what the price was per filter because I do not know what the budget was. I know what the analysis budget was, but that is the same as doing it on the ground. I do not know what it costs to fly the airplane. The cost is very high. I think that when you start looking at doing measurements aloft is when the need for high time resolution data would really pay. You do not have the option to run a filter sampler for four hours when you are flying around in an airplane. You want data every few minutes.

Dr. Lowell Ashbaugh (UCD): I think what you really need for aloft measurements is remote sensing from the ground such as a lidar. That will give you continuous information over a much longer range and a much longer time. Aircraft sampling is extremely expensive and lidar sampling is expensive also. But overall, I think you would find the lidar less expensive and you would get more data. With a lidar you cannot get speciation as with an airplane, but you can get a long-time record with a lidar looking upward and get the time and vertical profile resolution that you need.

Q: Can you get speciation from a balloon?

A: Dr. Lowell Ashbaugh (UCD): There are limitations, but it may be a cost-effective way to get the speciated data that is necessary.

Dr. Tom Cahill (UCD): We are trying to develop a continuous spectrometer for airplanes that can be used and read continuously while the plane is flying. There is a source at U.C. Berkeley which allows you to analyze very small areas, a few microns across. So one in principal can make a sampler that is about the size of a fist that will allow you to get resolution, in say ten minutes, of aerosol versus time. When we start talking about the health effects associated with fine particles, we know that it is not just $PM_{2.5}$ and below alone. At various places and times there may be things like ultra fine insolubles, ultra fine solubles, strange organics, etc. I think that the capability is there and we need to simply have someone ask us to do it and to set up some sort of mechanism.

Q: To Andrew Ranzieri (ARB): Is it correct that the only PM data base from aloft that would be useful to you as a modeler would be speciated and not just mass?

A: Andrew Ranzieri (ARB): I would think that since we have very limited data aloft, any information would be helpful. But I think we would like to have speciated information.

Q: We are planning a large-scale field program for the San Joaquin Valley and surrounding air basins, probably in the year 2000. Part of our plan is that we obviously have to have some measurements of PM aloft and of course at the surface. Since we all know that we need information aloft, if you had a fixed budget of x-million dollars, could you identify what percentage of the budget should be set aside to get aloft measurements versus ground based measurements while recognizing that you can probably get higher quality ground based measurements than what you can aloft?

A: Fred Lurmann (STI): We first need to recognize that what we know about PM aloft right now compared to ozone is different. Most of the aircraft data that I have seen for PM aloft suggests that the levels are much lower as you go up above the mixed layer and you get into clean tropospheric air. That is not the case for ozone. The PM pool may not be as large, but we do not know that very well. It is just the characteristics of the data that we have seen so far. I think that if it was suggested to have more than ten percent of the resources go into aloft measurements, that might be the point where there would be an imbalance. Realistically, there is a need for understanding the PM chemistry, size, etc., on the ground. We do need to know how the mass and some of the components vary as you go aloft. But I do not think it is as important as it is with ozone episodes where there is a huge pool of ozone aloft.

Dr. Mark Jacobson (Stanford): In Los Angeles, in the top of the mix layer, there are huge spikes near San Bernardino and a little less near Claremont because of pollution going up the mountains and then returning. Therefore, there are high concentrations in the mix layer, but high up in the mix layer such that they are not captured by ground measurements. I think above the mix layer it probably drops off quite a lot, but in the mix layer the vertical resolution is needed to capture the high concentrations of PM. It would be nice to have at least one site that continuously measures high up in the atmosphere just to gauge what is there. There does not have to be a lot of them, but they should be in representative areas of the model in order to get an idea of spatial changes. There is not a need for as many as compared to ground-based measurements.

Dr. Lowell Ashbaugh (UCD): We placed our lidar outside of Davis and ran it pointing straight up for a couple of days. We saw some very interesting particle plumes aloft. My first question when I saw the results was, is that a cloud? There were no clouds, it was completely clear the whole time. There is definitely structure to the vertical profile that changes throughout the day and can be easily seen with a lidar up to eight kilometers.

Q: What time of the year were the lidar measurements at Davis made? Was there any agricultural burning going on at that time?

A: Dr. Lowell Ashbaugh (UCD): I think it was last September when those measurements took place.

Dr. Tom Cahill (UCD): The period was before the rice burning season. There was no obvious rice burning nearby, but it does not mean that something was not burning 50 miles away. It was a period that

was hot and dry and there was a period of a lot of fine soil at one point. We have no idea where these strange echoed layers are coming from. But we notice the same profiles in the Sierra Nevada as we go up the mountain. The aerosols change qualitatively and at about 4,000 or 5,000 feet when the ozone peaks, there is a chemical shift up the mountains which probably represents the vertical shift over the valley floor. There is a rich sulfur layer at the top and a much more mixed soil rich layer towards the bottom. But there is not much data.

Q: What approaches are available to model annual average violations and what types of enhancements would be needed for the routine network to collect the data to drive those models?

A: Fred Lurmann (STI): I have gone through a couple of rounds of trying to estimate annual averages in Los Angeles for $PM_{10,}$ not $PM_{2.5}$, for sulfates and nitrates which are primarily in the finer fraction. The options are limited and there are two approaches that can be used. One is to use a fairly simplified model and model everyday of the year, which has not worked all that well. The second option is to model a representative number of episodes over the whole year. I do not think that this approach has been explored in California. Scientifically, this has far more appeal because of using models which incorporate better science, as we know it, and applying them for a smaller number of periods and trying to come up with a weighted annual average. I think the technology is there to run 3D models with gas phase chemistry in simplified aerosol modules for a year without many problems. To do detailed aerosol calculations for a year, for chemistry and size, is still prohibitive. I do not think it can be done unless you have multiple super computers. The simple one or two size section models can be done; it's a matter of exploring it. In terms of the data needs for annual modeling, it is rare that anyone runs prognostic meteorological models for a whole year. Therefore, you rely on the observed meteorological data, and clearly it is important to have both the surface and aloft well represented in order to do a reasonable job on the wind fields and mixing heights over that time period. I think this has been one of the major limitations in past efforts to do annual models in California. We have had fairly crude meteorological upper air data. That situation is improving as more profilers are being installed at PAMS stations and operated on a routine basis. So I think a better job can be done with newer data.

Dr. Pradeep Saxena (EPRI): I agree with Fred in terms of not simplifying the chemistry and meteorology, but doing a few episodes. I think U.S. EPA used it very successfully for acid rain. I think they chose about 30 episodes in those days and it worked out for a representative annual average.

Fred Lurmann (STI): I think what we have to recognize is that we can do it with two or three episodes of two or three days duration. One needs to get up to the point of modeling 1/4 to 1/6 of the days in the year to come up with a reasonable annual average. In the South Coast we found that with the simple model the answer was the same whether you modeled everyday of the year or one in every three days. But you had to model a substantial amount of time in order to come up with credible and consistent annual averages. Trying to do this with a few number of events will not work.

Dr. Susanne Hering (ADI): I would think that annual average numbers can be obtained from measurements. The real driving force behind the modeling is to understand how those particle concentrations would have been different on those days if the emissions had been different. Therefore, the reason for doing the models is not just for annual averages.

bullet2/RDG-6.1/5-14-98